Distribution and Natural History of Opisthobranch Gastropods from Las Cruces, Baja California del Sur, Mexico

BY

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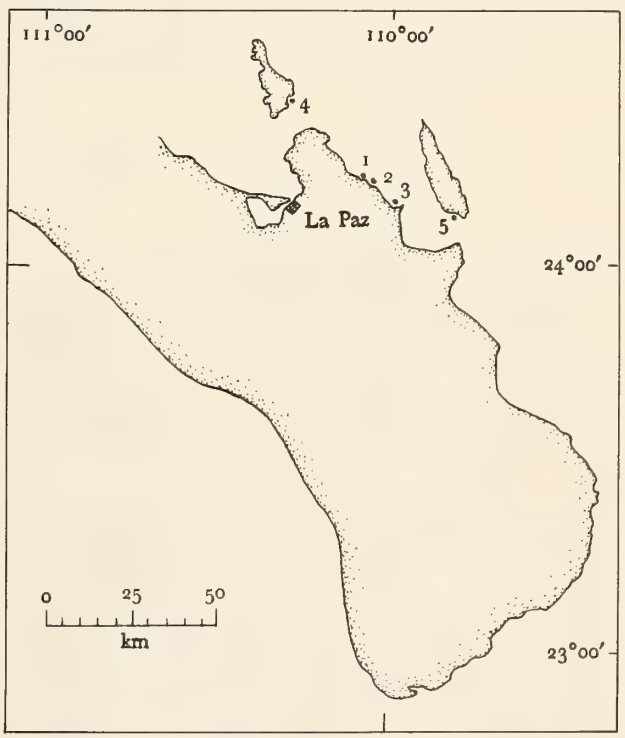
(2 Maps)

INTRODUCTION

THIS PAPER REPORTS the natural history and occurrence of 11 opisthobranch species found during July 20 to July 28, 1972, in the vicinity of the Las Cruces Biological Station, Baja California del Sur, Mexico. Habitat preferences, feeding, taxonomic and evolutionary considerations are given for some of the species.

Diving and collecting were done at 5 localities (Map 1): 1) Bahía Carisalito, 4km north of the Station; 2) Bahía Las Cruces, the cove and bay immediately in front of the Station; 3) the bay north of Punta Gorda, 8km south of the Station; 4) southeastern Isla Espíritu Santo, 36km northwest of Las Cruces; and 5) the bay on the southwestern edge of Isla Cerralvo, 25km southeast from Las Cruces.



Map 1

Southern tip of Baja California, Mexico, showing the five collecting localities of this study

SACOGLOSSA

ELYSIIDAE

Tridachiella diomedea (Bergh, 1894)

Six specimens of *Tridachiella diomedea* were obtained from Islas Espíritu Santo and Cerralvo, and from Bahía Carisalito. Five were between 8 and 25mm in total length, and one was 43mm long.

The type locality of *Tridachiella diomedea* is approximately 1.6km off the western coast of Isla Cerralvo, at 24°11′N; 109°55′W, nearly ⅔ the distance from Bahía

Las Cruces to my collecting locality on the southwestern edge of Isla Cerralvo.

Table 1

Latitude and Longitude of the Localities within the Gulf of California approximated to the nearest minute

Puerto Peñasco	31°18′ N; 133°35′ W
Puertecitos	30°21′ N; 114°38′ W
Puerto de Lobos (Cabo Tepoca)	30°16′ N; 112°51′ W
Puerto Refugio, Isla Angel de la Guarda	29°33′ N; 113°35′ W
Bahía de Los Angeles	28°53′ N; 113°30′ W
Isla Cedros (on the Pacific)	28°07′ N; 115°11′ W
Bahía San Carlos	27°56′ N; 111°04′ W
W. Isla San Francisco	24°50′ N; 110°35′ W
SE Isla Espíritu Santo	24°27′ N; 110°19′ W
Bahía Las Cruces	24°13′ N; 110°05′ W
SW corner Isla Cerralvo	24°09′ N; 109°49′ W

ANASPIDEA

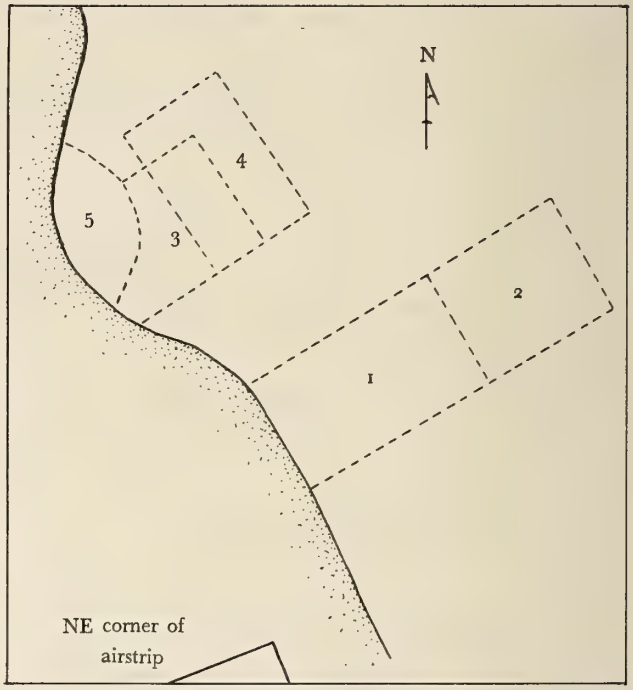
Aplysiidae

Stylocheilus longicauda (Quoy & Gaimard, 1824)

Although one of the most common opisthobranchs throughout the Gulf of California, *Stylocheilus longicauda* was first correctly reported as occurring in the Gulf just over 6 years ago (Farmer, 1967). Prior to this, it was reported as *Notarchus (Aclesia)* sp. (Steinbeck & Ricketts, 1941) and as *Aclesia rickettsi* MacFarland, 1966. Engel & Hummelinck (1936) and Roller (1970) list the synonyms of *S. longicauda.*

Stylocheilus longicauda characteristically occurs intertidally, among tidepools, or in shallow subtidal depths on various kinds of seaweeds (Quoy & Gaimard, 1824; Pease, 1860; Ostergaard, 1955; Marcus & Marcus, 1963; Kay, 1964; Bertsch, 1970). It also occurs on rocky or sandy substrate (Kay, *op. cit.*; Farmer, 1967).

Since there is little knowledge about its ecology, I studied the intertidal and subtidal region at the southern end of Bahía Las Cruces in order to find out if *Stylocheilus longicauda* shows a preference for a particular habitat. I chose this study area (immediately west of the Las Cruces airstrip) because of its accessibility, the ease with which quadrats could be measured and quantitative data gathered, the large numbers of *S. longicauda* living in this general region, and the diversity of habitats within a small area. Variables, such as fluctuations in water temperature and wave action, were negligible, thus reducing factors



Map 2

Sketch of southern tip of Bahía Las Cruces, showing the transect sites studied to determine the habitat preference of *Stylocheilus longicauda*

that might cause different population densities of *S. longicauda* at the study site. The study was conducted within the 2-day period of July 20-21, 1972, to eliminate seasonal fluctuations, and within the same time period each afternoon (between 1300 and 1600 hours) to minimize any differences that may exist in diurnal activity periods.

The area was divided into 5 quadrat regions (Map 2).

Region 1 was a rocky intertidal region, covered by 30 to 75 cm of water during the study period. It extended from 5 to 14 m from the shoreline. A unicellular blue-green alga was growing on the rocks. It formed a thin, sparse layer over the rocks, making them very slippery. There were no diatoms nor other organisms encrusting this alga.

Region 2 consisted of the subtidal area immediately beyond region 1, and had the same kind of alga. However, the rocks were 1.0 to 1.5 m below the water surface, and the area, starting at 15 m, extended to 25 m from the shore. This area was readily separable from area 1 in the

field, because 2 species of echinoderms occurred in it and not in the first area: *Ophiocoma aethiops* Lütken (the blunt-spined brittle star) and the long-spined urchin, *Diadema mexicanum* Agassiz.

Region 3 was situated 33 m northwest of quadrats 1 and 2, and was sampled 6 to 10 m from shore. It consisted of a rocky and sandy substrate, covered by dense growths of a trabeculated alga (*Caulerpa* cf. *C. pinnata*) with flattened, pinnate branches.

Region 4 consisted of an area of *Polysiphonia* algal growths overlapping locality 3. The algal masses served to readily distinguish the quadrat regions. Area 4 was in 1 m of water, 6 to 14 m from shore, with a rocky substrate.

Region 5 was a circular area, distinguished by a sandy substrate, 1.0 to 1.5 m deep, surrounded by region 3 seaward, and by the shore westward. The *Caulerpa* alga from region 3 was scattered throughout region 5, with shoots spreading out from the rocks and across areas of bare sand.

Table 2

Frequency of Occurrence of *Stylocheilus longicauda* in five different habitats

Transect number	Total size of area examined	Number of specimens of *Stylocheilus* found	Number of rocks or algae clumps
	(in cm²)		examined
1	5202	0	18
2	5300	0	18
3	7350	53	13
4	4750	85	18
5	10125	61	5

The algae from areas 3, 4, and 5 were heavily encrusted with diatoms. The most common species were *Licmophora abbreviata* Agardh, 1831 (60% of the diatoms), and *Grammatophora oceanica* (Ehrenberg, 1854) Grunow, 1881 (comprising about 10% of the diatom specimens).

Measurements of areas and counts of number of specimens of *Stylocheilus longicauda* occurring in each of the 5 quadrat regions were made *in situ* by snorkel diving. During the day, *S. longicauda* actively crawls over the surface of rocks and algae, permitting easy counting of specimens with little disturbance to the habitat.

Rocks covered by the 3 kinds of algae were randomly chosen, their length measured with a ruler, and then the number of *Stylocheilus longicauda* occurring on the algae was recorded. The squares studied in region 5 were randomly chosen areas of sandy bottom; distances were measured by a ruler, and the specimens occurring within each square were counted.

The total area studied in regions 1 to 4 was approximated by considering the width of the rock or algal mass as $\frac{2}{3}$ its total length. These figures were rounded off to the nearest centimeter for area determination and then added together to give the total area sampled in each quadrat.

Table 3

Density of *Stylocheilus longicauda* Within the Five Different Habitats

Transect number	Density
1	0 per 5202 cm²
2	0 per 5300 cm²
3	1 per 140 cm²
4	1 per 55 cm²
5	1 per 170 cm²

The results of this study are given in Tables 2 and 3. There is a definite correlation between the kind of alga and the relative abundance of *Stylocheilus longicauda*. Thick, dense mats of algae, covered with large amounts of diatoms (as in regions 3, 4, and 5) are a preferred habitat for *S. longicauda* in the Las Cruces area. There is an extremely low occurrence of *S. longicauda* in areas that do not exhibit their preferred habitat's characteristics.

Observations that I have made in other parts of the Gulf of California strengthen the predictive value of the observed low abundances of *Stylocheilus longicauda* outside its characteristic preferred habitat.

While diving on the western side of Isla San Francisco on July 8 and 9, 1969, I found only 2 specimens of *Stylocheilus longicauda* (see BERTSCH, 1970). The algal covering on the rocks was similar to that encountered in quadrat regions 1 and 2, and the extremely low density of *S. longicauda* was comparable with that found in this study for that habitat.

During the last week of March, 1972, Gary and Scott Williams, Terrence Gosliner, Mark Noonan, Tim Elliott, and I collected 18 species of opisthobranchs from Puertecitos. No specimens of *Stylocheilus longicauda* were found, and no dense algal growths occurred at our collecting sites.

Other collecting that I did for this report yielded only 5 specimens of *Stylocheilus longicauda*. They were all

found together, under a rock, in 3 m of water, just north of Punta Gorda. The alga in this locality was similar to that found in regions 1 and 2, and the density of *S. longicauda* was not comparable with the numbers found in the dense algal growths at regions 3, 4, and 5. The collecting sites on southeast Isla Espíritu Santo and southwest Isla Cerralvo yielded no specimens of *S. longicauda*. This was predictable because neither locality had extensive, dense algal masses.

Feeding was observed in the field (in quadrat regions 3, 4, and 5) and in the laboratory. When feeding, *Stylocheilus longicauda* crawls over the alga and scrapes off the diatoms, which it consumes. An earlier report (Bertsch, 1970) that *S. longicauda* ate fronds of *Spyridia filamentosa* (Wulfen) Harvey, should be corrected to read that this animal eats the diatoms on *Sp. filamentosa*. *Stylocheilus longicauda* did not appear to be selective among the various diatoms on the alga. Since 2 species of diatoms on the algae comprised 70% of that population, the major food items that *S. longicauda* ate in the area studied were the diatom species *Licmophora abbreviata* and *Grammatophora oceanica*.

While feeding, the opisthobranchs continued crawling forward, everting the radula from the mouth (at which time it was readily visible to the naked eye), then retracting the radula with a slight upward jerk of the head. Radular strokes were quite rhythmic and rapid, often more than 1 per second. The animals expelled fecal pellets while eating.

NOTASPIDEA

Pleurobranchidae

Berthellina engeli Gardiner, 1936

A total of 5 specimens of *Berthellina engeli* were found, 1 from SE Isla Espíritu Santo, 1 from SW Isla Cerralvo, and 3 from Bahía Carisalito. The small specimens, between 10 and 20 mm in length, were all found on the underside of rocks. The negative phototaxis of *B. engeli* has already been reported (Bertsch, 1970).

NUDIBRANCHIA

Doridoida

Chromodorididae

Species of the genera *Chromodoris* Alder & Hancock, 1855, and *Hypselodoris* Stimpson, 1855, occur quite commonly throughout the Gulf of California. However, in two separate research visits to the Las Cruces region, I have observed a great variability in their abundance (Table 4). In July, 1969, 7 specimens of two species of *Chromodoris* were obtained during the period of an entire month from 28 collecting dives lasting 2 to 3 hours each. In July, 1972, a total of 31 specimens of 4 species of *Chromodoris* and *Hypselodoris* were obtained during a one-week period (July 20 to 26) from 7 collecting dives, lasting 2 - 3 hours each. The more than 400% increase in the occurrence of these animals emphasizes the unpredictable seasonality characteristic of many nudibranch species.

Table 4

Comparative Abundance of Four Species of Chromodorids in the years 1969 and 1972 in the Las Cruces region

Species	Number of specimens				Total specimens	
	Las Cruces		Isla Cerralvo			
	1969	1972	1969	1972	1969	1972
Chromodoris baumanni	0	1	0	0	0	1
Chromodoris norrisi	5	16	1	1	6	17
Chromodoris sedna	0	2	1	3	1	5
Hypselodoris sp.	0	8	0	0	0	8
Totals:	5	27	2	4	7	31

Chromodoris baumanni Bertsch, 1970

One 37 mm long specimen of *Chromodoris baumanni* was collected subtidally at Bahía Carisalito. By close examination (900 ×) of the "gelatinous" integument, I found long, thin, rod-like spicules scattered throughout the tissue. Marcus & Marcus (1967) previously reported that this species has no spicules.

Chromodoris norrisi Farmer, 1963

Both in July, 1969, and July, 1972, *Chromodoris norrisi* was the most frequently encountered chromodorid. It was typically found crawling on the sides or tops of rocks, in the sunlight. Sixteen specimens were measured, varying in total length from 21 to 46 mm; the median length was 28 mm.

Chromodoris sedna (Marcus & Marcus, 1967)

Five specimens of *Chromodoris sedna* were collected, varying in length from 13 to over 40 mm.

Hypselodoris sp.

Eight specimens of an undescribed *Hypselodoris* were found subtidally at the Las Cruces area – one at Bahía Carisalito, one at Las Cruces, and 6 just north of Punta Gorda. The largest specimen measured 57 mm long. I have also seen this species intertidally at Puertecitos (a

69 mm specimen, collected by Scott Williams on March 27, 1972).

The species of *Hypselodoris* from tropical west America are poorly known. Within the same year, *Hypselodoris agassizii* (Bergh, 1894) was synonymized with *H. californiensis* (in KEEN, 1971), and re-instated as a separate, valid species (SPHON, 1971) on the basis of external coloration. A third species, *H. aegialia* (Bergh, 1904), is known only from the type material.

The coloration of *Hypselodoris californiensis* is deep blue, with large yellow dots or streaks on the body. SPHON (1971) considers "a single, continuous yellow stripe along the border of the mantle" to be diagnostic. This stripe is apparently mentioned in the original description of *H. californiensis*: "A brighter, fine line seemed to border the margin of the mantle-edge and that of the foot" (BERGH, 1879), but it is not clear as to just what color Bergh considered the stripe. In his work on the "*Albatross*" material, BERGH (1894) mentions no yellow stripe on *H. californiensis*. Moreover, COCKERELL (1902), COCKERELL & ELIOT (1905), and MACFARLAND (1966) described a light blue or white marginal stripe.

The coloration of the mantle edge of *Hypselodoris californiensis* varies. A single, light yellowish, white, or pale blue stripe encircles the edge of the mantle. *Hypselodoris agassizii* can be distinguished by its multiple green and white marginal striping, and *H. aegialia* is green with whitish flecks.

POLYCERIDAE

Polycera alabe Collier & Farmer, 1964

The recorded range of *Polycera alabe* is from its type locality in the Pacific (Isla Cedros) to the northern end of the Gulf of California (KEEN, 1971). In the Gulf of California it has been found at Puertecitos (pers. observ., March, 1972), Puerto de Lobos (FARMER, 1971), Puerto Refugio (COLLIER & FARMER, 1964), and Bahía San Carlos (WILLIAMS & GOSLINER, 1971). The reported range of *P. alabe* consists of two disjunct sites: off the Pacific coast of Baja California, and in the northern part of the Gulf of California.

On July 24, 1972, I collected 5 4 - 5 mm long specimens of *Polycera alabe* from a cove on the southeastern side of Isla Espíritu Santo. This extends the known range of *P. alabe* 400 km to the south, and establishes an intermediate occurrence for this species between its two previously isolated populations. The distribution of *P. alabe* is now throughout the Gulf of California, and on the Pacific coast of Baja California to Isla Cedros.

DENDRODORIDIDAE

Dendrodoris krebsii (Mörch, 1863)

Two days after I left Las Cruces, on July 28, 1972, Andrew Toepfer and Gene Lombard found one specimen of *Dendrodoris krebsii* on the underside of a rock at Bahía Carisalito. The surface of the rock was covered with the encrusting coralline alga *Lithothamnion* sp. The preserved *D. krebsii* measures 25 mm in length.

Dendrodoris krebsii has been previously recorded from nearby Bahía La Paz (COLLIER & FARMER, 1964). This species is known to occur throughout the Panamic province north of Tenacatita, Jalisco (19°17'N; 104°54'W), and throughout the Caribbean faunal area from Florida, U. S. A., to Cananeia, Brazil (MARCUS & MARCUS, 1967).

Dendronotoida

BORNELLIDAE

Bornella sp.

On July 26, 1972, Thomas S. Cooke and Gary Stellern found 6 specimens of a new species of *Bornella* under rocks in 3 to 4 m of water at Bahía Carisalito. No genera of the family Bornellidae Fischer, 1883, have previously been reported from any part of the Pacific coast of the Americas.

All known species of the genus *Bornella* occur in tropical provinces. Nine were described in the Indo-West Pacific region from the coasts of Africa and Saudi Arabia to Japan and the Society Islands (Tahiti), 1 from St. Thomas in the Caribbean, and 1 has an unknown type locality (RUSSELL, 1971).

The closely related family Dendronotidae Sars, 1878, is largely restricted to north temperate and arctic seas (ROBILLIARD, 1970). The only exceptions to this are 2 specimens of *Dendronotus gracilis* Baba, 1949, collected from 9 - 24 m in New Zealand waters (ROBILLIARD, *op. cit.*), and the Panamic species *Dendronotus nanus* Marcus & Marcus, 1967. The close relationship between these two families can be explained on the basis of perhaps polyphyletic radiations from an ancestral bornellid-like group in the tropics, with one or more dispersals northward that lost the ceratal gills and evolved into the *Dendronotus* group, and adaptive radiations throughout the tropics that have given rise to the numerous species of *Bornella*.

Dotidae

Doto lancei Marcus & Marcus, 1967

The recorded sites where *Doto lancei* has been observed are all in the northern part of the Gulf of California, both on the Sonoran and Baja Californian coastlines. The type locality is Puerto Peñasco (Marcus & Marcus, 1967). Additional animals have been reported from Puerto de Lobos (Farmer, 1971), Bahía de Los Angeles (Keen, 1971), and Bahía San Carlos (Williams & Gosliner, 1971; also personal observations, December, 1970).

On July 25, 1972, while diving at the southwestern corner of Isla Cerralvo, I found specimens of *Doto lancei* crawling on *Aglaophenia*. Egg masses of *D. lancei* (Type A as described by Hurst, 1967) were seen on the fronds of the hydroid, and the nudibranchs were seen either on the fronds or crawling on the base of the stem.

Five specimens were collected and preserved. The largest specimen measured 7 mm in length when alive, and had 8 pairs of cerata, with 5 rows of ceratal tubercles and one apical tubercle. The proximal tubercles were specked with white dots, whereas each distal tubercle possessed a subapical black ring and a black apical spot.

This collection represents a southward range extension for *Doto lancei* of 442 km. The known range of *D. lancei* is now throughout the entire Gulf of California.

DISCUSSION ON DISTRIBUTIONAL RECORDS

The ranges of nudibranchs in tropical West America are confusing and little known. Over 15 species are known only from isolated locations on the northern Pacific coast of Baja California and in the northern part of the Gulf of California. Another 12 species are recorded only from the northern Gulf and 10 or more have been collected only in the vicinity of Panama Bay. Such scattered data and disjunct occurrence records admittedly result from the little amount of work that has been done on the nudibranch populations of tropical West America.

Data reported from this collection have extended the ranges of two nudibranch species throughout the Gulf of California. These range extensions and others (Bertsch, 1971; Ferreira, 1972; Ferreira & Bertsch, 1972; Sphon, 1972) need to be placed in a more comprehensive perspective. Those Panamic species with currently disjunct populations may eventually prove to have continuous ranges, similar to *Polycera alabe, Dendrodoris krebsii, Armina californica* (Cooper, 1862), *Spurilla chromosoma* Cockerell & Eliot, 1905, and other species with continuous ranges on both sides of the Baja California peninsula. Those species with extremely narrow ranges (based only on type material or a few scattered collections) possibly will be found along a wider latitudinal range within the Panamic province, similar to such widely distributed species as *Chromodoris baumanni, Ch. sedna, Doto lancei,* and *Flabellina telja* Marcus & Marcus, 1972. These hypotheses are consistent with the continuous ranges of many Panamic species (Keen, 1971) and with statistical analyses of the north-south length of nudibranch ranges within the Panamic province (Bertsch, 1973).

These remarks, however, are made only in view of other possible hypotheses: the ranges of the species may be disjunct presently (having at one time been continuous), the disjunct populations may be different species, and some species may be naturally rare with narrow ranges. Insufficient data from recent material, capricious taxonomy, and the lack of a fossil record, limit our current understanding of Panamic nudibranch distributions.

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